

NDCX-II Facility at Nazarbayev University
Lawrence Berkeley National Laboratory **DRAFT** Proposal to Nazarbayev University, Kazakhstan
Will Waldron, July 29, 2013

This goal of this proposal is to initiate the fabrication and operation of NDCX-II hardware at NU as well as the training of engineering and scientific staff to support NDCX-II activities. In addition to an induction cell and pulsed power test stand, an integrated front-end of NDCX-II will be operational at NU in approximately three years at a cost of about \$3M per year. **This is a preliminary estimate that will require further effort to refine for the purpose of a formal proposal. At this stage of the process, it is important that NU give LBNL feedback on the proposal content to make sure that this plan will meet the needs of NU and gain the support of the funding agencies.** The phases of this proposal will occur in series.

Phase I – Induction Cell and Pulsed Power Test Stand



The induction cell and pulsed power test stand allows detailed characterization of the performance of fabricated NDCX-II hardware. A stand-alone induction cell can be driven by a compression pulser or a Blumlein pulsed power system to study the tuning of acceleration gap voltage waveforms, timing jitter, voltage holding, diagnostic calibration, solenoid cooling, magnetic field measurements, and control system development. This test stand and the corresponding NDCX-II hardware will be fabricated and installed at LBNL with the participation of NU technical staff. After a short period of commissioning, the complete system will be shipped to NU where it will be installed and operated. This test stand can be used to train NU staff, but it also provides the platform for acceptance testing production NDCX-II hardware before final placement on the beamline.

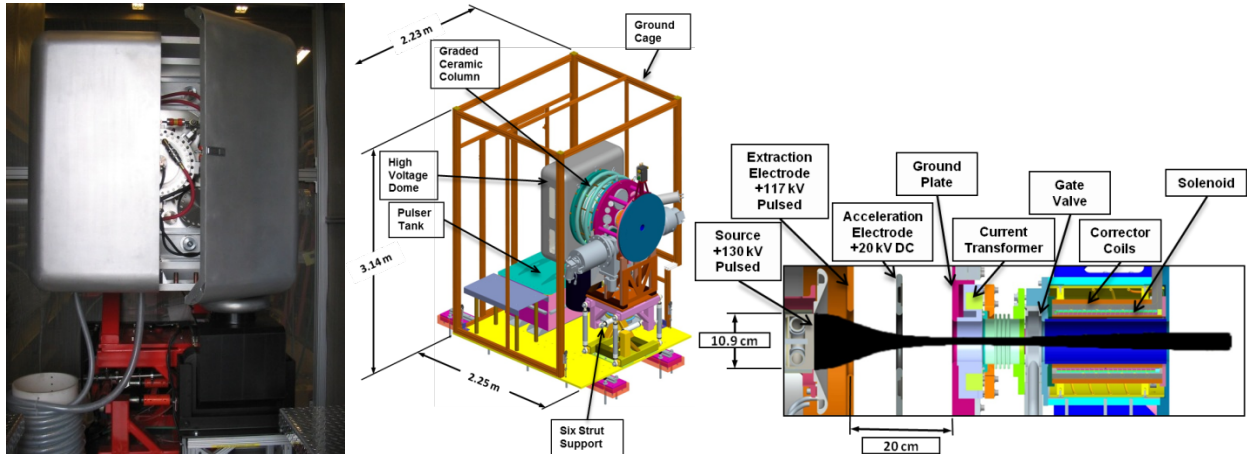
NU staff will also learn the NDCX-II engineering aspects, the ion source and beam physics, and the operational aspects directly from LBNL engineering and scientific staff.

Duration: The system will ship to NU in approximately 6 months.

Components: induction cell with solenoid
 Solenoid pulser
 Blumlein pulsed power system
 Compression pulser and core reset system
 Vacuum and oil recirculation system

Timing, control, and data acquisition system
Support structure

Phase II – Injector (and optional ion source test stand)



The injector is a duplicate of the NDCX-II injector at LBNL. All production documentation can be used to immediately start fabrication with the participation of NU technical staff. NU staff will learn the design's engineering aspects, the ion source and beam physics, and the operational aspects directly from LBNL engineering and scientific staff.

Duration: The injector will be complete in approximately 1 year.

Hardware Deliverables: Injector support and alignment structure
Injector and ion source assembly
Injector pulser system
Ion source filament power supply
Solenoid and corrector coils
Solenoid pulser
Corrector coil pulser
Vacuum system
Timing, control, and data acquisition system

Phase III – Induction Cell, Diagnostic Cell, and Pulsed Power Production



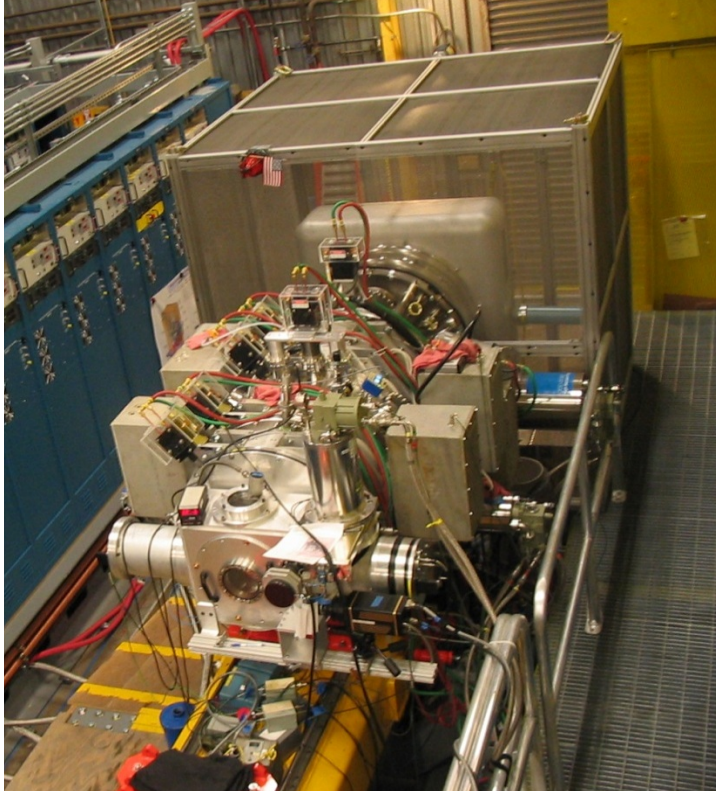
This phase is mainly a fabrication activity to provide the components for the NDCX-II front end. All production documentation can be used to immediately start fabrication with the participation of NU technical staff.

Duration: The fabrication of these induction cells and pulsed power systems will be complete in approximately 6 months.

Hardware Deliverables:

- 4 induction cells with solenoids
- 1 diagnostic cell and solenoid and corrector coils
- 2 compression pulser and core reset systems
- 2 Blumlein pulsed power systems
- 4 Solenoid pulsers
- 1 Corrector coil pulser

Phase IV – Integrated NDCX-II Front End



The NDCX-II front end is a duplicate of the system at LBNL. All production documentation can be used to immediately start fabrication with the participation of NU technical staff. NU staff will learn the design's engineering aspects, the ion source and beam physics, and the operational aspects directly from LBNL engineering and scientific staff.

Duration: The integrated NDCX-II front end will be complete, tested, and ready to ship to NU in approximately 1 year.

Hardware Deliverables: Injector (Phase II deliverable)

- 4 induction cells (Phase III deliverable)

- 1 diagnostic cell (Phase III deliverable)

- 2 Blumlein pulsed power systems (Phase III deliverable)

- 2 compression pulsers and core reset systems (Phase III deliverable)

- 5 Solenoid pulsers (Phase II and III deliverables)

- 2 Corrector coil pulsers (Phase II and III deliverables)

- 1 diagnostic end station with basic beam characterization diagnostics

- Support and alignment system

- Vacuum system

- Timing, control, and data acquisition system

Possible future phases to support the build-out of the NDCX-II machine:

V: Neutralized drift compression line, final focus, and target chamber with minimal diagnostics

VI: Target Diagnostics

VII: Additional induction cells and pulsed power systems for higher beam energy

Other Discussion Items:

As part of the previous proposal, there were explicit scientific collaborations on present and new experiments at LBNL. This proposal focuses on the NDCX-II hardware production and testing.

The choice of lithium and the implications for NDCX-II should be understood by NU. There are ion species and source technologies which may be attractive. An ion source test stand is used at LBNL to test small scale ion sources for emission characteristics (lifetime, current density, etc.). This test stand has been used to develop the fabrication techniques for the NDCX-II ion source and can be used to develop other ion sources. NU should consider a similar test stand to evaluate other ion species for NDCX-II and to maximize the scientific output of the facility.

At the end of this proposal, NU staff will be qualified to start production hardware fabrication and assembly at NU. During the various phases of this proposal, NU staff will see what is required to support NDCX-II hardware fabrication and assembly so that these requirements can be met at NU.

There are various upgrades that can be considered once the NDCX-II facility is functional. A short-pulse laser can provide an x-ray backlighter for a density diagnostic. The suite of target chamber diagnostics can be expanded to improve experimental capability. The addition of induction cells and pulsed power systems can increase the beam energy to access a wider experimental parameter space.

As part of the previous proposal, the idea of relocating NDCX-I to NU was identified as an option. This would give NU the ability to do near-term neutralized drift compression experiments (~ 1 year), provide staff training and student thesis work, and provide a platform for beam and experimental diagnostic development.